

**RTCA Special Committee 186, Working Group 3**

**ADS-B 1090ES MOPS Maintenance**

**Meeting #23**

**Teleconference**  
**November 1, 2007**

**Implementing the TCAS RA Broadcast on 1090ES**

**Gary Furr**  
**Engility Corporation, FAA Technical Center**

**Summary**

In January 2004 the ICAO ASP Technical Subgroup (TSG) proposed a method for broadcasting the TCAS RA information via a 1090 MHz Extended Squitter (1090ES) Message. This involved the use of the 1090ES Aircraft Status Message, TYPE=28 with the implementation of a new SUBTYPE=2. This proposal was accepted by ICAO and was implemented into what has now been accepted as ICAO Doc 9871, the “Technical Detailed Specifications for Mode S and Extended Squitter.” What follows is an informational Appendix that was developed for the Surveillance and Broadcast Services Ground Station Specifications, which specifies the details of the contents of the TCAS RA Message to allow the Ground Stations to receive, decode and report the contents of that 1090ES Message. The Draft Version 1.0 of Change 3 to DO-260A does not contain all of the required changes to DO-260A that will be required to fully implement the new Message, but much of the required information is contained either in this Appendix or in ICAO Doc 9871, both of which will be used to complete all needed changes to DO-260A in the next version of the Draft of Change 3 to DO-260A.



## **A. Format for the TCAS/ACAS RA Message and Definition of the CAT033 FRN**

### **A.1 Format for the TCAS/ACAS RA Message**

Since the collisions, and near collisions, of several sets of aircraft internationally, several regulatory authorities have advocated ways to obtain the Resolution Advisories (RA) downlink in a more timely fashion than was previously available from a scanning beam interrogator. The first alternative that was considered was to use the 1030 MHz RA broadcast that is transmitted once per second by TCAS/ACAS during an RA event. This RA broadcast was originally provided to make RA information available in airspace that was not covered by a Mode-S interrogator. For this reason, the 1030 MHz RA broadcast only identifies the transmitting TCAS/ACAS aircraft by its Mode-A code. While this will still provide useful identification in some airspace, it will not provide unique identification in Europe after the initiation of Mode-A conspicuity codes.

In early 2004 International authorities proposed using an Event-Driven 1090 MHz Extended Squitter (1090ES) to deliver the TCAS/ACAS RA broadcast. The 1090ES TCAS/ACAS RA Message broadcast overcomes the identity problem of the 1030 MHz RA broadcast since it can contain the same information as the RA message readout using the GICB protocol, including the aircraft ICAO 24-bit Address. A ground-based 1090ES receiver with an omni-directional receiving capability can provide TCAS/ACAS RA Messages to the ground much sooner than with a scanning beam antenna. It was determined that the TCAS/ACAS RA information could be easily defined as an addition to the existing 1090ES Aircraft Status Emergency Priority Message.

The airborne aircraft broadcast rates and priorities for the TCAS/ACAS RA Message are defined in ICAO Document 9871, §B.2.3.8.2. The format for broadcasting a 1090ES Aircraft Status Message with TCAS/ACAS RA Message content (1090ES Message TYPE CODE=28, Subtype=2) is defined here in Table A-1, and in ICAO Document 9871, Table B-2-97b. These rates, priorities and formats will be implemented in a future update to the 1090ES MOPS (RTCA/DO-260A).

The 1090ES Receiver Function **shall** receive and decode the 1090ES Aircraft Status Message, with TYPE CODE = 28 and Subtype = 2, and populate the FAA CAT033 report with the Message content as defined in §A.2.

**Table A-1: 1090ES Aircraft Status Message**  
**(Subtype 2: 1090ES TCAS/ACAS RA Broadcast Message)**

<b>Aircraft Status Message (TYPE CODE=28, Subtype=2)</b>								
<b>Message Bit #</b>	33 – 37	38 – 40	41 – 54	55 – 58	59	60	61 – 62	63 – 88
<b>“ME” Bit #</b>	1 – 5	6 – 8	9 – 22	23 – 26	27	28	29 – 30	31 – 56
<b>Field Name</b>	TYPE=28 [5]	Subtype=2 [3]	Active Resolution Advisories (ARA) [14]	RACs Record [4]	RA Terminated (RAT) [1]	Multiple Threat Encounter (MTE) [1]	Threat Type Indicator (TTI) [2]	Threat Identity Data (TID) [26]
	MSB      LSB	MSB      LSB	MSB      LSB	MSB      LSB			MSB      LSB	MSB      LSB

**Note:** “[#]” provided in a field indicates the number of bits in that field.

## A.2 Definition of the CAT033 FRN for the 1090ES TCAS/ACAS RA Message

Broadcast of the 1090ES Aircraft Status Message with TYPE CODE=28 and Subtype=2 will be accomplished by the 1090ES ADS-B airborne transmitter once per 0.8 seconds using the 1090ES event-driven protocol with a transmission priority that is defined in ICAO Document 9871, §B.2.5.5.3. The 1090ES TCAS/ACAS RA Message broadcast will begin within 0.5 seconds after the airborne transponder is notified of the initiation of a TCAS/ACAS RA. Broadcast of the 1090ES TCAS/ACAS RA Message will be terminated by the 1090ES airborne transmitter 10 seconds after the RA Terminated flag (Message Bit 59) transitions from ZERO to ONE. Transmission of the 1090ES TCAS/ACAS RA Message (TYPE CODE=28, Subtype 2) by the airborne transmitter will take priority over the broadcast of the 1090ES Aircraft Status, Emergency/Priority Status Message (TYPE CODE=28, Subtype=1).

Definition: 1090ES TCAS/ACAS Resolution Advisory Message

Structure: Fixed 6-byte data item.

Byte 1								Byte 2							
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
MSBActive Resolution AdvisoriesLSB														MSBRACs	
Byte 3								Byte 4							
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
LSBRecord		RA T	ME	Threat Type Indicator		MSBThreat Identity....									
Byte 5								Byte 6							
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
.....Data															LSB

### A.2.1 Active Resolution Advisories (ARA)

#### Encoding:

Bits 41 – 54: Active Resolution Advisories

The Active Resolution Advisories (ARA) subfield (Message Bits 41 – 54) **shall** indicate the characteristics of the RA, if any, generated by the TCAS/ACAS associated with the transponder transmitting the subfield. The bits in the ARA **shall** have meanings determined by the value of the “Multiple Threat Encounter” (MTE) subfield (Message Bit 60), and, for vertical RAs, the value of Message Bit 41 of ARA. The meanings of Bits 41 through 54 **shall** be as follows, and in Table A-2:

When ARA Bit 41 = 0, AND MTE, Bit 60 = 0, no vertical RA has been generated.

**Table A-2: Active Resolution Advisories (ARA)**

<b>MTE (Bit 60)</b>	<b>0 or 1</b>	<b>1</b>
<b>ARA Bit 41</b>	<b>1</b>	<b>0</b>
<b>ARA Bit 42</b>	0 = RA is preventive	0 = RA does not require a correction in the upward sense
	1 = RA is corrective	1 = RA requires a correction in the upward sense
<b>ARA Bit 43</b>	0 = upward sense RA has been generated	0 = RA does not require a positive climb
	1 = Downward sense RA has been generated	1 = RA requires a positive climb
<b>ARA Bit 44</b>	0 = RA is not increased rate	0 = RA does not require a correction in the downward sense
	1 = RA is increased rate	1 = RA requires a correction in the downward sense
<b>ARA Bit 45</b>	0 = RA is not a sense reversal	0 = RA does not require a positive descend
	1 = RA is a sense reversal	1 = RA requires a positive descend
<b>ARA Bit 46</b>	0 = RA is not altitude crossing	0 = RA does not require a crossing
	1 = RA is altitude crossing	1 = RA requires a crossing
<b>ARA Bit 47</b>	0 = RA is vertical speed limit	0 = RA is not a sense reversal
	1 = RA is positive	1 = RA is a sense reversal
<b>ARA Bits 48 – 54</b>	Reserved for TCAS/ACAS III	Reserved for TCAS/ACAS III

## A.2.2 Resolution Advisories Complement Record (RACs Record)

### Encoding:

Bits 55 – 58: RACs Record

The 4-bit RACs Record subfield (Message Bits 55 – 58) **shall** indicate all of the currently active RACs, if any, received from other TCAS/ACAS aircraft. The bits in the RACs Record subfield **shall** have the following meanings:

**Table A-3: RACs Record Subfield**

<b>Bit</b>	<b>Resolution Advisory Complement</b>
55	Do not pass below
56	Do not pass above
57	Do not turn left
58	Do not turn right

A bit set to ONE (1) **shall** indicate that the associated RAC is active.

A bit set to ZERO (0) **shall** indicate that the associated RAC is inactive.

**A.2.3 RA Terminated (RAT)**Encoding:

Bit 59: RA Terminated

This 1-bit RA Terminated subfield (Message Bit 59) **shall** indicate when an RA previously generated by TCAS/ACAS has ceased being generated.

**Table A-4: RA Terminated (RAT)**

<b>Coding</b>	<b>Meaning</b>
0	TCAS/ACAS is currently generating the RA indicated in the ARA subfield
1	The RA indicated by the ARA subfield has been terminated

Notes:

1. *After an RA has been terminated by TCAS/ACAS, it is still required to be reported by the Mode-S transponder for a period of  $18 \pm 1$  seconds. The RA Terminated indicator may be used, for example, to permit timely removal of an RA indication from an Air Traffic Controller's display, or for assessments of RA duration within a particular airspace.*
2. *RAs may terminate for a number of reasons: normally, when the conflict has been resolved and the threat is diverging in range; or when the threat's Mode-S transponder for some reason ceases to report altitude during the conflict. The RA Terminated indicator is used to show that the RA has been removed in each of these cases.*

**A.2.4 Multiple Threat Encounter (MTE)**Encoding:

Bit 60: Multiple Threat Encounter (MTE)

This 1-bit Multiple Threat Encounter (MTE) subfield (Message Bit 60) **shall** indicate whether two or more simultaneous threats are currently being processed by the TCAS/ACAS threat resolution logic.

**Table A-5: Multiple Threat Encounter (MTE)**

<b>Coding</b>	<b>Meaning</b>
0	One threat is being processed by the resolution logic (when ARA bit 41 = 1); or no threat is being processed by the resolution logic (when ARA bit 41 = 0)
1	Two or more simultaneous threats are being processed by the resolution logic

**A.2.5 Threat Type Indicator (TTI)**Encoding:

Bits 61 - 62: Threat Type Indicator (TTI)

This 2-bit Threat Type Indicator (TTI) subfield (Message Bits 61 – 62) **shall** define the type of identity data contained in the Threat Identity Data (TID) subfield.

**Table A-6: Threat Type Indicator (TTI)**

Coding	Meaning
0	No identity data in the Threat Identity Data (TID) Subfield
1	TID Subfield contains a Mode-S transponder address
2	TID Subfield contains altitude, range and bearing data
3	Not Assigned

### A.2.6 Threat Identity Data (TID)

#### Encoding:

Bits 63 – 88: Threat Identity Data

This 26-bit Threat Identity Data (TID) subfield (Message Bits 63 – 88) **shall** contain the Mode-S address of the threat, or the altitude, range, and bearing, if the threat is not Mode-S equipped. If two or more threats are simultaneously processed by the TCAS/ACAS resolution logic, then the TID **shall** contain the identity or position data for the most recently declared threat.

If TTI=1, then TID **shall** contain in Bits 63 – 86 the aircraft address of the threat, and bits 87 and 88 **shall** be set to ZERO (0).

If TTI=2, then TID **shall** contain the following three subfields for altitude, range and bearing:

#### A.2.6.1 Threat Identity Data Altitude (TIDA)

If TTI=2, then this 13-bit subfield (Message Bits 63 – 75) **shall** contain the most recently reported Mode-C altitude code of the threat.

**Table A-7: Threat Identity Data Altitude (TIDA)**

Coding	Meaning												
Bit	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode-C code bit	C <sub>1</sub>	A <sub>1</sub>	C <sub>2</sub>	A <sub>2</sub>	C <sub>4</sub>	A <sub>4</sub>	0	B <sub>1</sub>	D <sub>1</sub>	B <sub>2</sub>	D <sub>2</sub>	B <sub>4</sub>	D <sub>4</sub>



### A.2.6.2 Threat Identify Data Range (TIDR)

If TTI=2, then this 7-bit subfield (Message Bits 76 – 82) **shall** contain the most recent threat range estimated by TCAS/ACAS.

**Table A-8: Threat Identity Data Range (TIDR)**

Coding ( <i>n</i> )	Meaning (Estimated Range in NM)
0	No range estimate available
1	Less than 0.05 NM
2 – 126	$(n-1)/10 \pm 0.05$ NM
127	Greater than 12.55 NM

### A.2.6.3 Threat Identity Data Bearing (TIDB)

If TTI=2, then this 6-bit subfield (Message Bits 83 – 88) **shall** contain the most recent estimated bearing of the threat aircraft, relative to the TCAS/ACAS aircraft heading.

**Table A-9: Threat Identity Data Bearing (TIDB)**

Coding ( <i>n</i> )	Meaning (Estimated Bearing in Degrees)
0	No bearing estimate available
1 – 60	Between $6(n-1)$ and $6n$ Degrees
61 – 63	Not Assigned

## **Implementing the TCAS RA Message on 1090ES**

Reference ICAO Doc 9871, §B.2.3.8.2, §B.2.5.5.3, and Table B-2-97b, plus the information in the above SBS Ground Station Specification Appendix for details on implementing the actual format.

This is a minimum list of changes that will be required in DO-260A related to adding the 1090ES Aircraft Status Message, TYPE=28, Subtype=2 requirements, formats and test procedures:

Table 2-14

Table 2-16

2.2.3.2.7.8

Figure 2-14b, Subtype=2

2.2.3.3.1.4.3

2.2.3.3.1.4.6.1

2.2.3.3.2.6.3

2.2.5.1.51

2.2.8.2

2.2.8.2.9

Table 2-102

2.4.3.2.7.1.3.15

2.4.3.2.7.8

2.4.3.3.1.4.3

2.4.3.3.1.4.6.1

2.4.3.3.2.6.3

2.4.5.1.51

2.4.5.2.11, Step 16

2.4.8.2.9

Table A-1

Table A-2

A.1.4.7.1

A.1.4.8 and A.1.4.8.1

A.1.4.9.16

A.1.6.4.3

Figure A-8b, Subtype=2

Appendix B – On Condition Messages

Appendix H – H.3.2.2

Appendix N – Figure N-6 (Version 0)